```
import pandas as pd
import numpy as np


encodings_to_try = ['utf-8', 'ISO-8859-1', 'cp1252']

for encoding in encodings_to_try:
    try:
        df = pd.read_csv('/content/sample_data/spam.csv', encoding=encoding)
        print(f"Successfully read the file using encoding: {encoding}")
        break
    except UnicodeDecodeError:
        print(f"Failed to read the file using encoding: {encoding}")
```

```
Failed to read the file using encoding: utf-8
Successfully read the file using encoding: ISO-8859-1
```

```
#show the first five rows of the dataset
df.head()
```

	v1	v2	Unnamed: 2	Unnamed: 3	Unnamed: 4
0	ham	Go until jurong point, crazy.. Available only ...	NaN	NaN	NaN
1	ham	Ok lar... Joking wif u oni...	NaN	NaN	NaN
2	spam	Free entry in 2 a wkly comp to win FA Cup fina...	NaN	NaN	NaN
3	ham	U dun say so early hor... U c already then say...	NaN	NaN	NaN
4	ham	Nah I don't think he goes to usf, he lives aro...	NaN	NaN	NaN

```
#show the rows and columns in the dataset
df.shape
```

```
(5572, 5)
```

Step 1 - Data Cleaning

```
#get information about the dataset
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 5572 entries, 0 to 5571
Data columns (total 5 columns):
 #   Column      Non-Null Count  Dtype 
---  ------      --------------  ----- 
 0   v1          5572 non-null   object
 1   v2          5572 non-null   object
 2   Unnamed: 2  50 non-null     object
 3   Unnamed: 3  12 non-null     object
 4   Unnamed: 4  6 non-null      object
dtypes: object(5)
memory usage: 217.8+ KB
```

```
#drop last three columns
df = df.drop(columns = ['Unnamed: 2', 'Unnamed: 3', 'Unnamed: 4'])
```

```
#show first five rows of the dataset
df.sample(5)
```

	v1	v2
4069	ham	Ok i wont call or disturb any one. I know all ...
4804	ham	Sorry for the delay. Yes masters
1635	ham	You have come into my life and brought the sun...
3916	ham	Eh ur laptop got no stock lei... He say mon mu...
3507	ham	Camera quite good, 10.1mega pixels, 3optical a...

```
#rename the column
df.rename(columns = {'v1':'target','v2':'text'}, inplace = True)

df.sample(5)
```

	target	text
3661	ham	What are you doing in langport? Sorry, but I'l...
4200	ham	Wylie update: my weed dealer carlos went to fr...
88	ham	I'm really not up to it still tonight babe
1257	ham	Am also doing in cbe only. But have to pay.
439	ham	But i have to. I like to have love and arrange.

```
#encoding the target column
from sklearn.preprocessing import LabelEncoder
encoder = LabelEncoder()
```

```
df['target'] = encoder.fit_transform(df['target'])
```

```
df.head()
```

	target	text
0	0	Go until jurong point, crazy.. Available only ...
1	0	Ok lar... Joking wif u oni...
2	1	Free entry in 2 a wkly comp to win FA Cup fina...
3	0	U dun say so early hor... U c already then say...
4	0	Nah I don't think he goes to usf, he lives aro...

```
#missing values
df.isnull().sum()

     target    0
     text      0
     dtype: int64
```

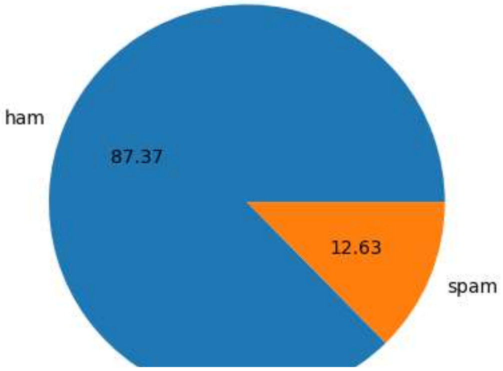
```
#check duplicate values
df.duplicated().sum()

     403
```

```
#remove duplicates
df = df.drop_duplicates(keep = 'first')
```

Step 2 - EDA

```
#show the spam and ham
df['target'].value_counts()

     0    4516
     1     653
     Name: target, dtype: int64
```

```
import matplotlib.pyplot as plt

# Assuming you have a DataFrame named df with a 'target' column
plt.pie(df['target'].value_counts(), labels=['ham', 'spam'], autopct='%0.2f')
plt.show()
```



```
#data is imbalanced
```

```
import nltk
```

```
nltk.download('punkt')
```

```
[nltk_data] Downloading package punkt to /root/nltk_data...
[nltk_data]   Package punkt is already up-to-date!
True
```

```
#number of characters in a sms
df['num_characters'] = df['text'].apply(len)
```

```
#fetch number of words
df['num_words'] = df['text'].apply(lambda x: len(nltk.word_tokenize(x)))
```

```
#fetch number of sentences
df['num_sentences'] = df['text'].apply(lambda x: len(nltk.sent_tokenize(x)))
```

```
df.head()
```

	target	text	num_characters	num_words	num_sentences
0	0	Go until jurong point, crazy.. Available only ...	111	24	2
1	0	Ok lar... Joking wif u oni...	29	8	2
2	1	Free entry in 2 a wkly comp to win FA Cup fina...	155	37	2
3	0	U dun say so early hor... U c already then say...	49	13	1
4	0	Nah I don't think he goes to usf, he lives aro...	61	15	1

```
#describe the dataframe
df[['num_characters', 'num_words', 'num_sentences']].describe()
```

	num_characters	num_words	num_sentences
count	5169.000000	5169.000000	5169.000000
mean	78.977945	18.455794	1.965564
std	58.236293	13.324758	1.448541
min	2.000000	1.000000	1.000000
25%	36.000000	9.000000	1.000000
50%	60.000000	15.000000	1.000000
75%	117.000000	26.000000	2.000000
max	910.000000	220.000000	38.000000

```
#for ham massages
df[df['target'] == 0] [['num_characters', 'num_words', 'num_sentences']].describe()
```

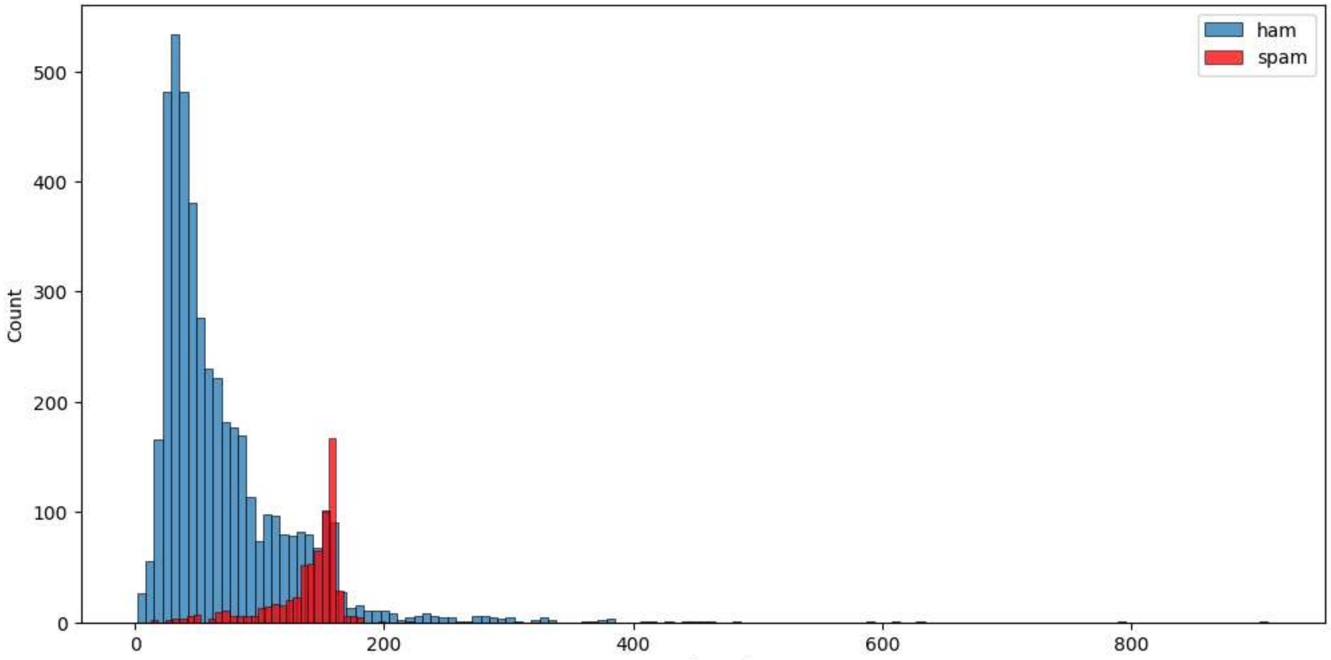
	num_characters	num_words	num_sentences
count	4516.000000	4516.000000	4516.000000
mean	70.459256	17.123782	1.820195
std	56.358207	13.493970	1.383657
min	2.000000	1.000000	1.000000
25%	34.000000	8.000000	1.000000
50%	52.000000	13.000000	1.000000
75%	90.000000	22.000000	2.000000
max	910.000000	220.000000	38.000000

```
#for spam massages
df[df['target'] == 1] [['num_characters', 'num_words', 'num_sentences']].describe()
```

	num_characters	num_words	num_sentences
count	653.000000	653.000000	653.000000
mean	137.891271	27.667688	2.970904
std	30.137753	7.008418	1.488425
min	13.000000	2.000000	1.000000
25%	132.000000	25.000000	2.000000
50%	149.000000	29.000000	3.000000
75%	157.000000	32.000000	4.000000
max	224.000000	46.000000	9.000000

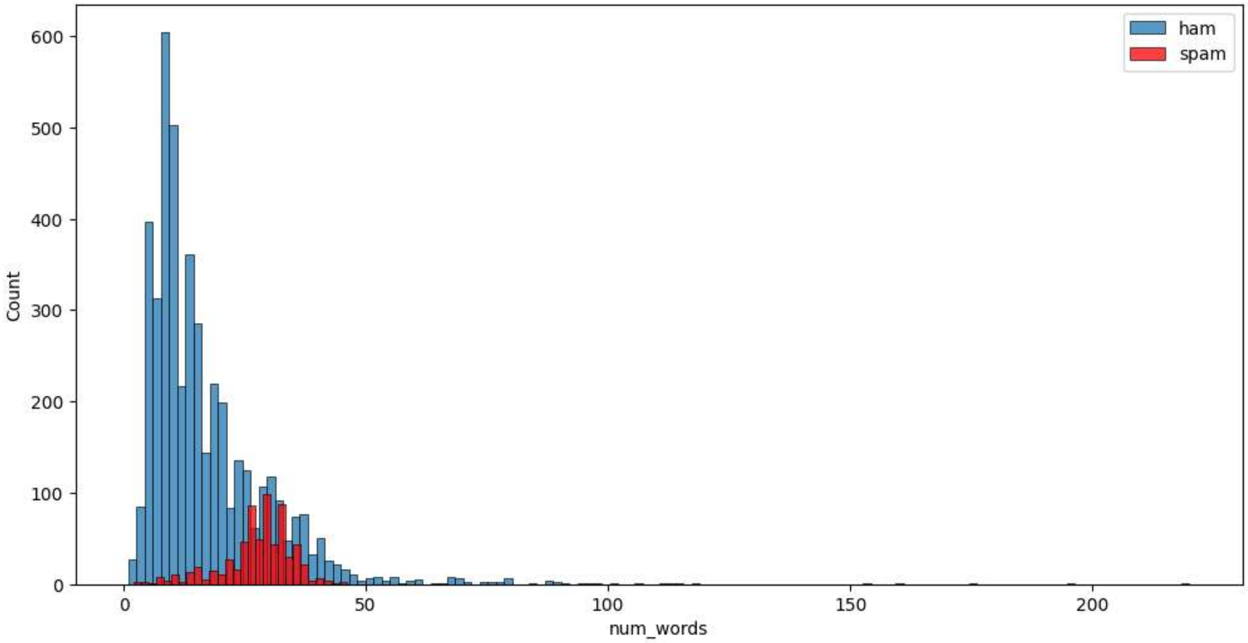
```
#plot histogram for ham and spam
import seaborn as sns


plt.figure(figsize=(12, 6))
sns.histplot(df[df['target'] == 0]['num_characters'], label='ham')
sns.histplot(df[df['target'] == 1]['num_characters'], color='red', label='spam')
plt.legend()
```

```
<matplotlib.legend.Legend at 0x7fb42fe26200>
```



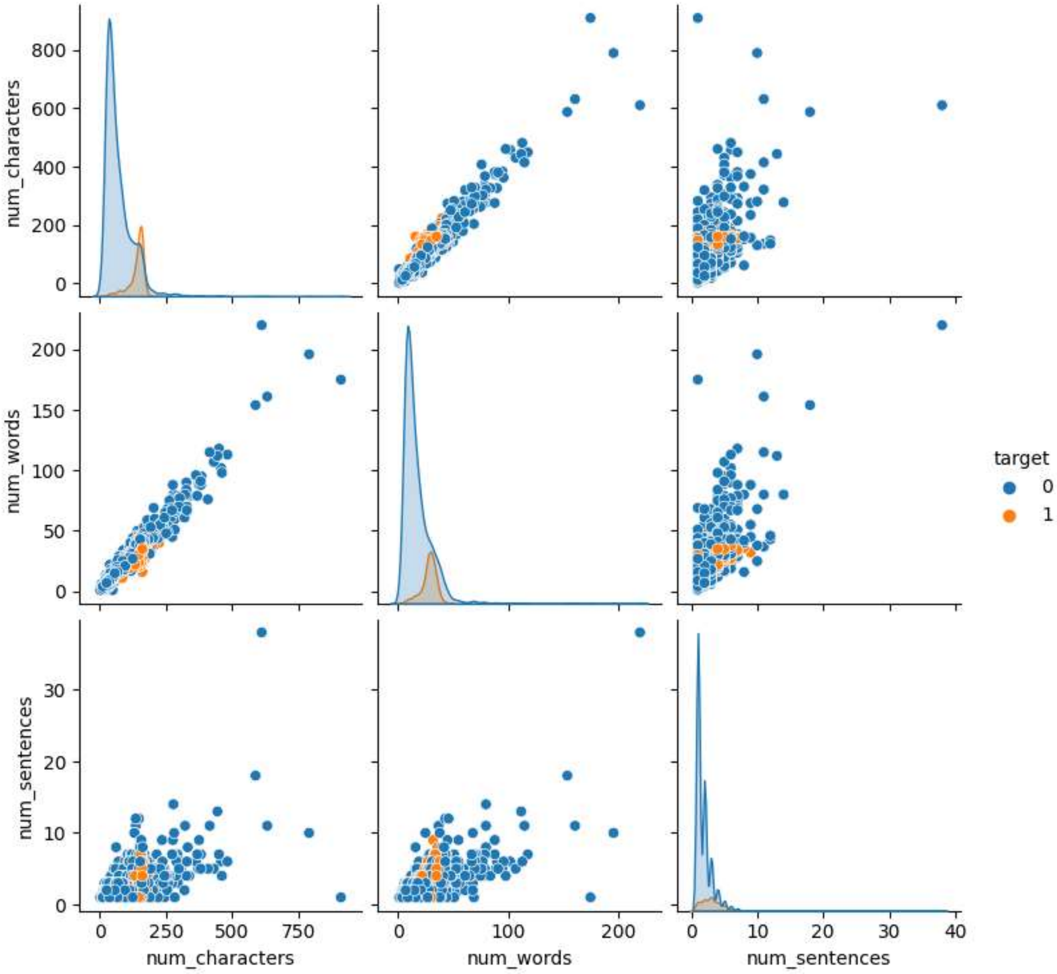
```
plt.figure(figsize=(12, 6))
sns.histplot(df[df['target'] == 0]['num_words'], label='ham')
sns.histplot(df[df['target'] == 1]['num_words'], color='red', label='spam')
plt.legend()
```

```
<matplotlib.legend.Legend at 0x7fb434a9eec0>
```



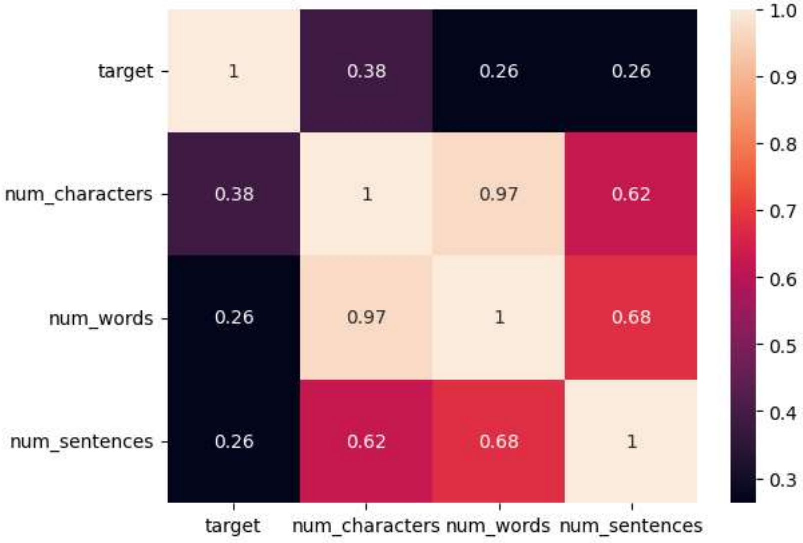
```
#find out the relation between characters, words, and sentences
sns.pairplot(df, hue = 'target')
```

```
<seaborn.axisgrid.PairGrid at 0x7fb435a11a20>
```



```
#show the correlation between columns
sns.heatmap(df.corr(), annot = True)
```

```
<ipython-input-317-890a373e7d41>:2: FutureWarning: The default value of numeric_only in DataFrame.corr is deprecated. In a
  sns.heatmap(df.corr(), annot = True)
<Axes: >
```



Step 3 - Data Preprocessing

Lower case

Tokenization

Removing special characters

Removing stop words and punctuations

Stemming

```
import nltk
from nltk.corpus import stopwords
from nltk.stem import PorterStemmer  # Import the Porter Stemmer
import string
```

```
nltk.download('stopwords')
```

```
[nltk_data] Downloading package stopwords to /root/nltk_data...
[nltk_data]   Package stopwords is already up-to-date!
True
```

```
# Initialize the Porter Stemmer
ps = PorterStemmer()
```

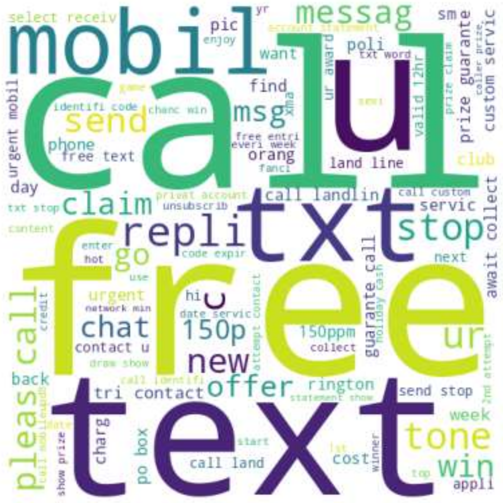
```
def transform_text(text):

  #make lowercase
  text = text.lower()

  #tokenization
  text = nltk.word_tokenize(text)

  #removing special charactes
  y = []
  for i in text:
    if i.isalnum():
      y.append(i)

  #removing stop words and punctuation
  text = y[:]
  y.clear()
  for i in text:
    if i not in stopwords.words('english') and i not in string.punctuation:
      y.append(i)

  #stemming
  text = y[:]
  y.clear()

  for i in text:
    y.append(ps.stem(i))


  return " ".join(y)
```

```
df['transform_text'] = df['text'].apply(transform_text)
```

```
df.head()
```

	target	text	num_characters	num_words	num_sentences	transform_text
0	0	Go until jurong point, crazy.. Available only ...	111	24	2	go jurong point crazi avail bugi n great world...
1	0	Ok lar... Joking wif u oni...	29	8	2	ok lar joke wif u oni
2	1	Free entry in 2 a wkly comp to win FA Cup fina...	155	37	2	free entri 2 wkli comp win fa cup final tkt 21...
3	0	U dun say so early hor... U c already then say...	49	13	1	u dun say earli hor u c alreadi say
4	0	Nah I don't think he goes to usf, he lives aro...	61	15	1	nah think goe usf live around though

```
#for spam massages
from wordcloud import WordCloud

wc = WordCloud(width=500, height=500, min_font_size=10, background_color='white')
spam_wc = wc.generate(df[df['target'] == 1]['transform_text'].str.cat(sep=" "))
plt.imshow(spam_wc)
plt.axis('off')
plt.show()
```



```
#for ham massages
from wordcloud import WordCloud

wc = WordCloud(width=500, height=500, min_font_size=10, background_color='white')
ham_wc = wc.generate(df[df['target'] == 0]['transform_text'].str.cat(sep=" "))
plt.imshow(ham_wc)
plt.axis('off')
plt.show()
```

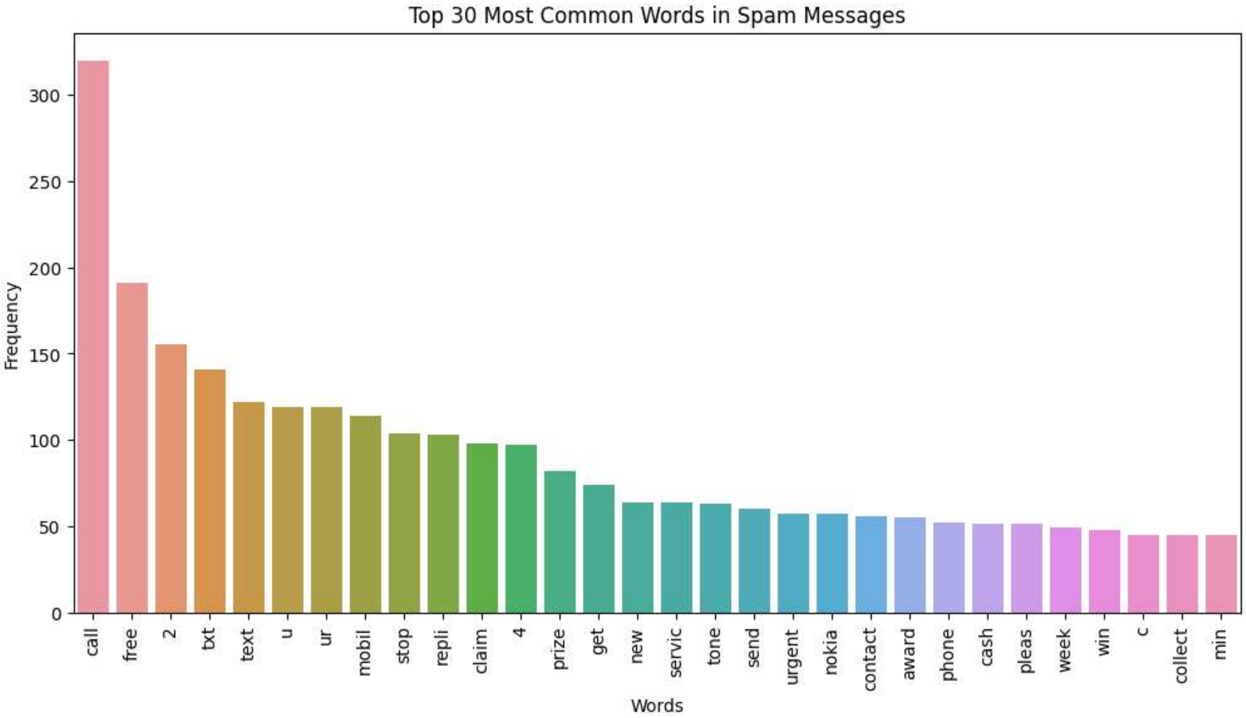
u
go
call
come
gt
lt
ok
got
get
time
still
love
ur
need
know
good
one
think
see
tell
day
da
work
back
give
take
miss
well
home
lor
today
send
meet
yeah
sorri
realli
alreadi
much
later
hope
ask
thank
friend
lol
text
oh
great
hey
n
free
pleas
let know
long
hi
im
wait
thing
plan
said
talk
someth
dont
right
feel
wat
keep
tomorrow
sleep
babe
late
msg
way
sure
fuck
hello
mind
stuff
mani
heart
leav
went
use
shop
guy
nice
everi
quit
lunch
person
life
even
someon
amp
end
morn
drive
wont
wonder
ii
ye
noth
sent
told
cant
actual
dat
yet
around
b
worri
hour
look
phone
gon
na
finish
place
care
fine
ya
best
tri
room
done
pl
week
find
ca
car
never
first
class
book

```
spam_corpus = []
#find out top 30 words which is used most in spam
for msg in  df[df['target'] ==  1]['transform_text'].tolist():
  for word in msg.split():
    spam_corpus.append(word)
```

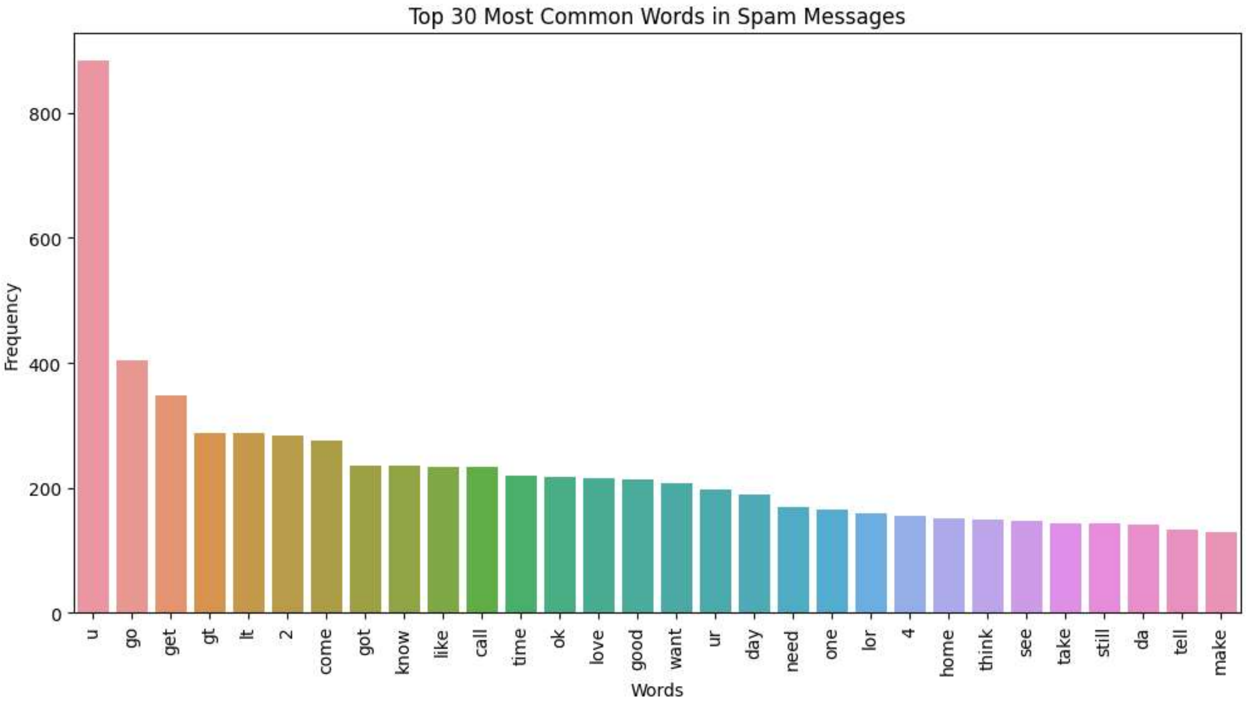
```
len(spam_corpus)
```

```
9939
```

```
from collections import Counter

# Create a DataFrame of the most common 30 words
word_counts = Counter(spam_corpus).most_common(30)
word_df = pd.DataFrame(word_counts, columns=['Word', 'Frequency'])

# Create a bar plot
plt.figure(figsize=(12, 6))
sns.barplot(data=word_df, x='Word', y='Frequency')
plt.xticks(rotation='vertical')
plt.xlabel('Words')
plt.ylabel('Frequency')
plt.title('Top 30 Most Common Words in Spam Messages')
plt.show()
```



```
spam_corpus = []
#find out top 30 words which is used most in ham
for msg in  df[df['target'] ==  0]['transform_text'].tolist():
  for word in msg.split():
    spam_corpus.append(word)


from collections import Counter

# Create a DataFrame of the most common 30 words
word_counts = Counter(spam_corpus).most_common(30)
word_df = pd.DataFrame(word_counts, columns=['Word', 'Frequency'])

# Create a bar plot
plt.figure(figsize=(12, 6))
sns.barplot(data=word_df, x='Word', y='Frequency')
plt.xticks(rotation='vertical')
plt.xlabel('Words')
plt.ylabel('Frequency')
plt.title('Top 30 Most Common Words in Spam Messages')
plt.show()
```



Step 4 - Model Building

```
from sklearn.feature_extraction.text import CountVectorizer, TfidfVectorizer

# Initialize the vectorizers
cv = CountVectorizer()
tfidf = TfidfVectorizer(max_features=3000)


# Fit and transform your text data into a document-term matrix
X = tfidf.fit_transform(df['transform_text']).toarray()
```

```
X.shape
```

```
     (5169, 3000)
```

```
y = df['target'].values
```

```
y
```

```
     array([0, 0, 1, ..., 0, 0, 0])
```

```
from sklearn.model_selection import train_test_split
```

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.2, random_state = 2)
```

```
from sklearn.naive_bayes import GaussianNB, MultinomialNB, BernoulliNB
from sklearn.metrics import accuracy_score, confusion_matrix, precision_score
```

```
gnb = GaussianNB()
mnb = MultinomialNB()
bnb = BernoulliNB()
```

```
gnb.fit(X_train, y_train)
y_pred1 = gnb.predict(X_test)
print(accuracy_score(y_test, y_pred1))
print(confusion_matrix(y_test, y_pred1))
print(precision_score(y_test, y_pred1))
```

```
0.8694390715667312
[[788 108]
 [ 27 111]]
0.5068493150684932
```

```
mnb.fit(X_train, y_train)
y_pred2 = gnb.predict(X_test)
print(accuracy_score(y_test, y_pred2))
print(confusion_matrix(y_test, y_pred2))
print(precision_score(y_test, y_pred2))
```

```
0.8694390715667312
[[788 108]
 [ 27 111]]
0.5068493150684932
```

```
# Fit the classifier with the training data
bnb.fit(X_train, y_train)

# Make predictions on the test data
y_pred3 = bnb.predict(X_test)

# Evaluate the model
accuracy = accuracy_score(y_test, y_pred3)
confusion = confusion_matrix(y_test, y_pred3)
precision = precision_score(y_test, y_pred3)

print("Accuracy:", accuracy)
print("Confusion Matrix:\n", confusion)
print("Precision Score:", precision)
```

```
Accuracy: 0.9835589941972921
Confusion Matrix:
 [[895   1]
 [ 16 122]]
Precision Score: 0.991869918699187
```

```
#tfidf --> BNB
```

```
from sklearn.linear_model import LogisticRegression
from sklearn.svm import SVC
from sklearn.naive_bayes import MultinomialNB
from sklearn.tree import DecisionTreeClassifier
from sklearn.neighbors import KNeighborsClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.ensemble import AdaBoostClassifier
from sklearn.ensemble import BaggingClassifier
from sklearn.ensemble import ExtraTreesClassifier
from sklearn.ensemble import GradientBoostingClassifier
from xgboost import XGBClassifier
```

```
svc = SVC(kernel = 'sigmoid', gamma = 1.0)
knc = KNeighborsClassifier()
dtc = DecisionTreeClassifier(max_depth = 5)
```

```
lrc = LogisticRegression(solver='liblinear', penalty = 'l1')
rfc = RandomForestClassifier(n_estimators=50, random_state = 2)
abc = AdaBoostClassifier(n_estimators=50, random_state = 2)
bc = BaggingClassifier(n_estimators=50, random_state = 2)
etc = ExtraTreesClassifier(n_estimators=50, random_state = 2)
gbdt = GradientBoostingClassifier(n_estimators=50, random_state = 2)
xgb = XGBClassifier(n_estimators=50, random_state = 2)
bnb = BernoulliNB()
```

```
clfs = {
    'SVC' : svc,
    'KN' : knc,
    'DT' : dtc,
    'LR' : lrc,
    'RF' : rfc,
    'AdaBoost' : abc,
    'BgC' : bc,
    'ETC' : etc,
    'GBDT' : gbdt,
    'xgb' : xgb,
    'BNB' : bnb
}
```

```
def train_classifier(clf, X_train, y_train, X_test, x_test):
  clf.fit(X_train, y_train)
  y_pred = clf.predict(X_test)
  accuracy = accuracy_score(y_test, y_pred)
  precision = precision_score(y_test, y_pred)

  return accuracy, precision
```

```
train_classifier(svc, X_train, y_train, X_test, y_test)
```

```
(0.9758220502901354, 0.9747899159663865)
```

```
accuracy_scores = []
precision_scores = []

for name, clf in clfs.items():

  current_accuracy, current_precision = train_classifier(clf, X_train, y_train, X_test, y_test)

  print('For', name)
  print("Accuracy -", current_accuracy)
  print("Precision - ", current_precision)

  accuracy_scores.append(current_accuracy)
  precision_scores.append(current_precision)
```

```
For SVC
Accuracy - 0.9758220502901354
Precision -  0.9747899159663865
For KN
Accuracy - 0.9052224371373307
Precision -  1.0
For DT
Accuracy - 0.9274661508704062
Precision -  0.8118811881188119
For LR
Accuracy - 0.9584139264990329
Precision -  0.9702970297029703
For RF
Accuracy - 0.9758220502901354
Precision -  0.9829059829059829
For AdaBoost
Accuracy - 0.960348162475822
Precision -  0.9292035398230089
For BgC
Accuracy - 0.9584139264990329
Precision -  0.8682170542635659
For ETC
Accuracy - 0.9748549323017408
Precision -  0.9745762711864406
For GBDT
Accuracy - 0.9468085106382979
Precision -  0.9191919191919192
For xgb
```

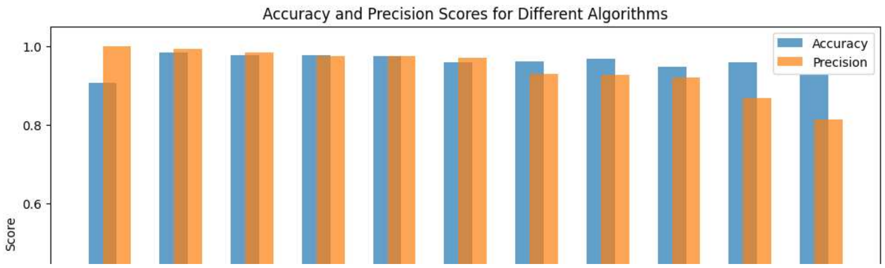
```
Accuracy - 0.9671179883945842
Precision -  0.9262295081967213
For BNB
Accuracy - 0.9835589941972921
Precision -  0.991869918699187
```

```
performance_df = pd.DataFrame({'Algorithm':clfs.keys(), 'Accuracy':accuracy_scores, 'Precision':precision_scores}).sort_values('Precision',as
```

```
performance_df
```

	Algorithm	Accuracy	Precision
1	KN	0.905222	1.000000
10	BNB	0.983559	0.991870
4	RF	0.975822	0.982906
0	SVC	0.975822	0.974790
7	ETC	0.974855	0.974576
3	LR	0.958414	0.970297
5	AdaBoost	0.960348	0.929204
9	xgb	0.967118	0.926230
8	GBDT	0.946809	0.919192
6	BgC	0.958414	0.868217
2	DT	0.927466	0.811881

```
performance_df = pd.DataFrame({'Algorithm': clfs.keys(), 'Accuracy': accuracy_scores, 'Precision': precision_scores}).sort_values('Precision'

# Create a bar plot to show both accuracy and precision scores
fig, ax = plt.subplots(figsize=(12, 6))

# Plot accuracy scores
ax.bar(performance_df['Algorithm'], performance_df['Accuracy'], width=0.4, label='Accuracy', align='center', alpha=0.7)

# Plot precision scores
ax.bar(performance_df['Algorithm'], performance_df['Precision'], width=0.4, label='Precision', align='edge', alpha=0.7)

# Set plot labels and title
plt.xlabel('Algorithm')
plt.ylabel('Score')
plt.title('Accuracy and Precision Scores for Different Algorithms')

# Add a legend
plt.legend()

# Rotate x-axis labels for better readability
plt.xticks(rotation='vertical')

# Show the plot
plt.show()
```



Model Improvement

```
#step - 1: Tfidf max_features(3000)
#step - 2: Scaling the X value(X.fit_transform)
#step - 3: Voting: combination of best performance algorithms
#step - 4: stacking
```

```
import pickle
pickle.dump(tfidf, open('vectorizer.pkl', 'wb'))
pickle.dump(bnb, open('model.pkl', 'wb'))
```